3861

SCOPE OF WORK

FOR

ACID AND CHLORINATION TREATMENTS OF

RE-INJECTION WELLS

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RE-INJECTION WELLS

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1.0 INTRODUCTION

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This scope of work:

- Outlines how re-injection wells will be treated for plugging using an acid treatment solution and then chlorinated.
- Provides the requirements for activities performed by the site wide-drilling contractor, Moodys.
- Directs the field support provided by Environmental Monitoring Water Monitoring Personnel, and ARRWP Personnel.

Treating re-injection wells becomes necessary when bacterial growth and mineral scale within the well screen, filter pack and/or adjacent formation cause a decline in well performance. In the past re-injection wells have been chlorinated first, then treated with acid. Based upon the recommendation of experts in the field of treating re-injection wells, this order will be reversed. The re-injection wells will undergo acid treatment first, followed by chlorination.

The following is a general overview of the treatment process. More detailed procedures and responsibilities are provided in subsequent sections.

Pre-Treatment Activities

- Downcomers will be pulled from the well.
- A downhole camera survey will be conducted.
- The water level and total depth of the well will be measured and recorded.
- A groundwater sample will be bailed from the well and analyzed for pH, chlorides, and ortho-phosphates.
- A soft wire brush will be used to clean out the inside surface of the well screen and sump.
- Any material that has accumulated in the bottom of the well will be removed.

Acid Treatment Activities

- The acid treatment solution will be prepared and blended in holding tanks.
- The acid treatment solution will be gravity fed into the well.
- The well will be surged to distribute the acid treatment solution in the well.

- The pH of water in the well will be measured. If the pH is at or below 3, the well will be allowed to sit overnight. If the pH is above 3, the well will receive a second, smaller dose of acid treatment solution.

- The well will be allowed to sit overnight

- The well will be surged the next day and then "vigorously pumped" to remove spent solution and other waste materials.

Chlorination Activities

- The chlorine solution will be prepared in holding tanks.

- The chlorine solution will be gravity fed into the well.

- The well will be surged to distribute the chlorine solution.

- The well will be allowed to sit overnight

- The well will be surged briefly the next day, and then vigorously pumped to remove spent chlorine solution and other waste materials.

Post Treatment Activities

- A sample of water will be bailed from the well and tested for chlorides, ortho-phosphates and pH.

- Before the downcomers are reinstalled, a performance test will be conducted. Treated groundwater will be injected into the well at a rate of 200 gpm for approximately one hour or until water levels in the well have appeared to stabilize.

- A downhole camera survey will be conducted

- The treatment rig will be demobilized and moved off the well site.

- Downcomers will be reinstalled.

2.0 CHEMICAL SAFETY PRECAUTIONS

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This section lists the specific chemicals used for well rehabilitation and special safety precautions. The chemicals to be used for treating re-injection wells are listed in Table 1.

TABLE 1
CHEMICALS APPROVED FOR TREATING RE-INJECTION WELLS

Chemical	Synonym	Staging Volumes (per well location)	Phase
12.5 % Sodium Hypochlorite	Concentrated Bleach	(4) 55 gallon drums	Liquid
31-37% Hydrochloric Acid	Muriatic Acid	(8) 55 gallon drums	Liquid
75% Phosphoric Acid	White Phosphoric Acid	(8) 55 gallon drums	Liquid
NW-310	Acid Enhancer	NA	Liquid
100% Sodium Thiosulfate	Disodium Salt	(6) 50 pound bags	Powder
100% Sodium Carbonate	Soda Ash	(6) 50 pound bags	Powder
100% Sodium Bicarbonate	Baking Soda	NA	Powder

Specific health and safety requirements are provided in the Project Specific Health and Safety Requirements Matrix (PSHSRM) for Well Rehabilitation (MTX-2053), Chemicals/Hazardous Materials Work Permit (Chem/Haz Permit), and related Environmental Monitoring Procedures (as referenced in this SOW). Several important safety precautions are repeated below.

USE EXTREME CARE, always add each chemical to water first, **AND NEVER MIX TWO CHEMICALS DIRECTLY TOGETHER.** When staging, handling, and using the well treatment chemicals ensure mixing of pure chemicals does not occur. The concentration of chemicals in use can be extremely dangerous and reactive if mixed together.

FOLLOW personal protective equipment (PPE) specified in the Chem/Haz Permit.

STAGE acids on diked Herculite® (plastic) sheeting with absorbent spill pads and a minimum of 5 feet away from other staging areas.

STAGE sodium hypochlorite on diked Herculite® (plastic) sheeting with absorbent spill pads and a minimum of 5 feet away from other staging areas.

STAGE all chemicals a minimum of 15 feet from the well.

STAGE solid materials (i.e., sodium thiosulfate, sodium bicarbonate, and sodium carbonate) together and 5 feet away from the other staging areas.

AVOID INHALING VAPORS AND/OR BEING SPLASHED with any chemicals used during well rehabilitation.

WATCH for smoke-like vapors during the mixing of treatment solutions, introduction of treatment solutions to the well, and during surging operations.

3.0 RESPONSIBILITIES

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The site-drilling contractor (currently Moodys) under the direct supervision of Fluor Fernald Inc. personnel will conduct well rehabilitation activities. Descriptions and identification of key project personnel or organizations are provided below:

Aquifer Restoration and Wastewater Project (ARWWP) Engineer is responsible for:

- Interfacing with Water Monitoring Personnel regarding the activities within this scope of work
- Reporting to ARWWP management any problems associated with the activities under this scope of work.
- Coordinating removal and replacement of downcomers with ARWWP Operations personnel.
- Coordinating the staging of 5,000-gallon tanker trucks with ARWWP Operations.

Aquifer Restoration and Wastewater Project (ARWWP) Hydrogeology Group Technical Lead is responsible for:

- Providing direction and guidance to Water Monitoring Personnel as required.
- Reporting to ARWWP management of any problems associated with the activities under this scope of work.
- Assisting the ARWWP Engineer as required.

Water Monitoring Field Oversight Personnel are Responsible for:

- Providing direct field oversight of Moody's to ensure compliance with scope of work, health and safety matrix, and applicable permit's and procedures.
- Documenting all sampling and field activities.
- Interfacing with ARWWP personnel on scope, schedule and any problems associated with the well rehabilitation activities.
- Interfacing with ARWWP Environmental Compliance to request approvals for wastewater discharge.
- Collecting samples and measurements as required by this scope of work as Moody's completes each chemical addition or removal.
- Performing downhole camera surveys.

- Documenting that the proper quantities of chemicals are used when mixing the acid and chlorination treatment solutions.
- Coordinate sample analysis with the on-site laboratory.
- Coordinate with WAO and Radiological Control Groups.

Site Drilling Contractor (Moodys) is responsible for:

- Conducting the well treatment activities.
- Mixing the treatment solutions
- Administering the treatment solutions into the well
- Surging the treatment solutions in the well
- Providing, installing, and operating a pump capable of pumping 200 gpm
- Providing an enclosed hook-up to tanker trucks.

ARWWP Operations (OPS) is responsible for:

- Pulling and installing the downcomers into the well
- Providing tanker trucks for the placement and transport of pumped water
- Providing Motor Vehicle Operator(s) (MVOs) for the tanker trucks
- Handling and disposing of pumped well water.

ARWWP Safety and Health Lead is responsible for:

- Providing health and safety monitoring in support of well rehabilitation activities.

ARWWP Environmental Compliance Lead is responsible for:

- Approving wastewater discharges to treatment facilities per site procedure EP-00005, *Controlling Wastewater Discharges into the FEMP Wastewater Treatment System.*

4.0 PRE-TREATMENT ACTIVITIES

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ARWWP Operations Personnel shall pull the downcomers from the well.

Water Monitoring Personnel shall conduct a camera survey per EM Procedure EQT-08, *Down-hole Camera* following removal of the well equipment. However, if the water in the well is turbid as a result of removing the equipment, the well will be allowed to sit until the turbidity has decreased enough to allow a good video survey. The ARWWP Engineer will be briefed on the survey results prior to initiation of chemical treatment. The videotape of the camera survey shall be archived in the Water Monitoring project files for future reference and review.

Water Monitoring Personnel shall measure the water level and the total depth of the well using EM Procedure SMPL-05, Groundwater Level/Total Depth Measurements.

Water Monitoring personnel shall bail a sample of groundwater from the well using a bailer. The pH of the sample will be measured in accordance with Environmental Monitoring (EM) Procedure EQT-02, *Horiba Water Quality Meter*. The sample will be submitted to the AWWT lab for analysis of chlorides and ortho-phosphates. Sample container types and preservatives are tabulated below.

PRE-TREATMENT SAMPLE

Number of Samples	Sample Matrix	Analyte List	Method of Analysis	Preservative	Sample Volume	Container Type	Laboratory	Sample Turn Around Time
1	Water	Chloride Ortho-phosphate	2504 2516	Cool to 4° C	500 ml	Plastic	AWWT	24 hours

Preparation for field activities performed by EM personnel shall follow the guidelines set forth in EM Procedure ADM-02, *Field Project Prerequisites*.

Moodys will use a soft wire brush to gently clean the inside of the well screen and sump. ARWWP personnel, based on the results of the video camera survey will direct the amount of time that the screen will be brushed. The objective will be to remove anything that can easily be removed mechanically prior to administering the acid treatment.

Moodys will bail out any material within the screen and sump. Any material removed from the well will be containerized until screened for radioactivity by Radiological Control. Waste Disposition will be directed by WAO.

5.0 ACID TREATMENT ACTIVITIES

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In the past, large doses of concentrated hydrochloric acid have been used in attempts to remediate and control plugging in the re-injection wells. The large doses of concentrated acid alone though were not adequate. It is believed that the acid reacted too quickly, bacterial slime produced from the acid treatment was not held in suspension and subsequently not adequately removed from the well.

At the recommendation of subject experts in the field of water well rehabilitation, a mixture of acids will be used to prolong the reaction time of the acid, and an "acid enhancer" will be added to the acid mixture. The acid-enhancer (NW-310) helps to break up the biofilm as well as suspend material for easier removal from the well upon pumping.

5.1 PREPARATION OF THE ACID TREATMENT SOLUTION

DANGER: NEVER ADD WATER TO ACID, ALWAYS ADD ACID TO WATER. NEVER MIX CHEMICALS DIRECTLY TOGETHER, ALWAYS ADD CHEMICALS TO WATER

LOGISTICS: DO NOT BEGIN MIXING THE ACID SOLUTION UNTIL TANKER TRUCKS HAVE BEEN COMMITTED TO SUPPORT PUMPING THE SPENT ACID SOLUTION FROM THE WELL.

WHEN STAGING CHEMICALS AT THE WELL-SITE, ATTEMPTS SHOULD BE MADE TO LIMIT THE QUANTITY OF CHEMICALS TO JUST WHAT IS NEEDED AT THAT WELL. ROUNDING QUANTITIES UP TO THE NEAREST CONTAINERIZED VOLUME IS ACCEPTABLE.

The re-injection wells will be treated with a 10% solution of mineral acids (hydrochloric and phosphoric) and NW-310. Mixing instructions are provided below. The chemicals will be mixed into water in holding tank(s). When purchasing chemicals, try to only purchase what will be needed to limit any left over quantities.

The drilling subcontractor, under the direction of Water Monitoring Personnel, will mix the acid treatment solution. Table 2 provides the quantities of chemicals to be used to prepare the acid treatment solution.

To mix, start with a known volume of potable or treated waters (Table 2, Column 2). Add 37% concentrated HCL acid to the known volume of potable or treated water (Table 2, Column 3). Add 75% concentrated phosphoric acid to the solution (Table 2, Column 4). Add 100% concentrated NW-310 (Table 2, Column 5). Following mixing, the pump will be flushed out with no more than 5 gallons of water.

After all chemicals have been added to the tank, the acid treatment solution will be blended using a re-circulation technique. The solution will be pumped from the bottom of the tank to the top of the tank in a closed system using a small pump until it is well mixed. Following pumping, the pump will be flushed out with no more than 5 gallons of water. Volumes listed in Table 2 are rounded to the nearest gallon.

TABLE 2
VOLUMES FOR ACID TREATMENT SOLUTION

1	2	3	4	5	6
Well	Starting volume of potable or treated water (gallons)	Add gallons of HCL	Add gallons of phosphoric Acid (gallons)	Add gallons of NW-310	Total Vol. of Acid treatment solution (gallons)
IW-8	119	30	4	4	167
IW-9	320	76	10	11	427
IW-10	581	137	17	20	765
IW-11	816	191	24	28	1069
IW-12	625	147	18	22	822

Table Footnote: Starting volumes are 10 gallons less than needed to arrive at the total volume shown in Column 6 of Table 2. The operators will flush out the pump used to add the chemicals to the tank with 5 gallons of water. The operators will flush out the pump used to blend the chemicals in the tank with 5 gallons of water.

NOTE: The following densities were used to calculate the volumes shown in Table 2; 37% HCL = 9.9 lbs./gal, 75% H_3PO_4 = 13 lbs./gal, and 100% NW-310 = 10 lbs./gal. Density of final acid solution = 8.74lbs. /gal.

The acid portion of the treatment solution is by volume 75% hydrochloric and 25% phosphoric acid.

The following formulas were used to calculate the volumes shown in Table 2:

1) *(Total Volume)*(density of solution) = Weight of solution*
2) *(Weight of solution) * (target acid concentration) = Lbs. of acid*
3) *(75%) * (Lbs. of Acid) = Lbs. of HCL*
4) *(25%) * (Lbs. of Acid) = Lbs. of H_3PO_4*
5) *(Lbs. of HCL)/(conc. of HCL) = Lbs. of Conc. HCL*
6) *(Lbs. of H_3PO_4)/(conc. of H_3PO_4 = Lbs. of Concentrated H_3PO_4*
7) *(Lbs. of Concentrated HCL)/(density of HCL) = Gallons of HCL*
8) *(Lbs. of Concentrated H_3PO_4)/(density of H_3PO_4) = Gallons of H_3PO_4*
9) *(Lbs. of Solution) * (target conc. of NW-310) = Lbs. of NW-310*
10) *(Lbs. of NW-310)/density of NW-310) = Gallons of NW-310*
11) *Starting Volume of Potable Water = Total Volume – Volume of HCL – Volume of H_3PO_4 – Volume of NW-310.*

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Example calculation for IW-8:

1) *(167 gallons) * (8.7424 lbs./gallon) = 1459.98 lbs.*
2) *(1459.98 lbs.) * (0.10) = 146 lbs.*
3) *(75%) * (146 lbs.) = 109.5 lbs. of HCL*
4) *(25%) * (146 lbs.) = 36.5 lbs. of H_3PO_4*
5) *(109.5 lbs. of HCL)/(.37) = 295.94 lbs. of Conc. HCL*
6) *(36.5 lbs. of H_3PO_4)/(.75) = 48.67 lbs. of Conc. H_3PO_4*
7) *(295.94 lbs. of Conc. HCL)/(9.9 lbs./gallon) = 29.9 gallons of HCL*
8) *(48.67 lbs. of Conc. H_3PO_4)/(13.3 lbs./gallon) = 3.7 gallons of H_3PO_4*
9) *(1459.88 lbs.) * (.03) = 43.8 lbs. of NW-310*
10) *(43.8 gallons of NW-310)/(10 lbs./gallon) = 4.4 gallons of NW-310*
11) *(167 gallons)-(30 gallons HCL)-(4 gallons H_3PO_4)-(4 gallons of NW-310) = 129 gallons of water.*
12) *129 gallons of water – 10 gallons (flushing pump) = 119 gallons.*

The total volume was determined by multiplying the volume of standing water in the well by 2. The water level recorded when the well was first put into operation was used to calculate the total volume. The water level today (summer of 2001) is lower, so the calculated final volumes found in this SOW are conservative toward the high side.

5.2 GRAVITY FEED THE ACID TREATMENT SOLUTION INTO THE WELL

CAUTION: HAVE A HOSE AND POTABLE OR TREATED WATER SUPPLY READY AND NEAR THE WELL WHEN THE ACID TREATMENT SOLUTION IS DISPENSED INTO THE WELL. IF FOAMING OCCURS, HOSE DOWN THE FOAM AT THE MOUTH OF THE WELL. IF NECESSARY, AS A LAST RESORT TO STOP FOAMING AT THE MOUTH OF THE WELL, POUR SOME CALCIUM BICARBONATE DOWN THE WELL. THE NW-310 SHOULD OFFSET THE PROBABILITY OF CALCIUM CARBONATE PRECIPITATING IN THE WELL.

The drilling subcontractor will gravity feed the acid treatment solution into the well. Twenty-five percent by volume should be placed just below the top of the water table. Fifty-percent by volume should be placed into the well at the top of the well screen. Twenty-five percent by volume should be placed into the well just above the base of the well screen. Table 3 presents the volumes required for each re-injection well.

If the top of the well screen is higher than the water level, then 25% of the acid treatment solution by volume should be placed into the well just below the water table. Fifty-percent by volume should be placed into the well half way between the water table and base of the screen. Twenty-five percent by volume should be placed into the well at the base of the screen.

TABLE 3
ACID SOLUTON DISPENSING VOLUMES

Well	25% just below the water table, (gallons)	50% at the top of the well screen, or half way between water table and base of screen (gallons)	25% at the base of the Screen (gallons)	Total Volume dispensed (gallons)
IW-8	42	83	42	167
IW-9	107	214	106	427
IW-10	191	383	191	765
IW-11	267	535	267	1069
IW-12	206	411	205	822

5.3 SURGING THE ACID TREATMENT SOLUTION IN THE WELL

The drilling subcontractor will distribute the acid treatment solution into the formation by surging the well with a tight fitting surge block. The sump will also be surged to loosen and disrupt any bacterial growth. Begin surging near the base of the sump, 15 minutes at each 2.5-foot interval of screen. Be careful not to hit the base of the sump.

Following completion of the surging, Water Monitoring Personnel will bail a sample of water from the well and measure the pH using a pH strip. If the pH is at or below 3, the well will be allowed to sit overnight, and the field crew should proceed with Step 5.7 the next day. If the pH is above 3, an additional dose of acid treatment solution will be added to the well, proceed to Section 5.4.

NOTES: The objective is to surge every 10-foot section of sump and screen for 60 minutes.

5.4 PREPARATION OF A SECOND ACID TREATMENT SOLUTION DOSE

If the pH of the well water after surging the first acid treatment solution dose is above 3, an additional acid treatment solution dose will need to be prepared and added to the well.

The additional acid dose of Acid Treatment Solution will be smaller in volume than the first dose; 20% by volume of the first dose. The drilling subcontractor, with the direction of Fluor Personnel, will blend the second Acid Treatment Solution Dose using the same re-circulating procedure used to blend the first dose.

Following pumping the chemicals into the tank the pump will be flushed with 5 gallons of water. Following blending of the chemicals in the tank the pump will be flushed out with 5 gallons of water.

Volumes used to mix the second dose are provided in Table 4, and rounded to the nearest gallon.

TABLE 4
VOLUMES FOR SECOND DOSE (IF REQUIRED)
20% (BY VOLUME) OF ORIGINAL ACID TREATMENT SOLUTION DOSE

1	2	3	4	5	6
Well	Starting volume of potable or treated water (gallons)	Add gallons of HCL	Add gallons of phosphoric acid (gallons)	Add gallons of NW-310	Final volume of Additional dose (gallons)
IW-8	15	6	1	1	33
IW-9	55	15	2	3	85
IW-10	108	27	3	5	153
IW-11	154	38	5	6	214
IW-12	116	29	4	5	164

NOTES: Starting volumes shown in Table 4 are 10 gallons less than needed to arrive at the total volume shown in Column 6 of Table 4. Operators will flush out the pump used to add the chemicals to the tank with 5 gallons of water. Operators will flush out the pump used to blend the chemicals in the tank with 5 gallons of water.

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5.5 GRAVITY FEED THE SECOND ACID TREATMENT SOLUTION INTO THE WELL

CAUTION: HAVE A HOSE AND POTABLE OR TREATED WATER SUPPLY READY AND NEAR THE WELL WHEN THE ACID TREATMENT SOLUTION IS DISPENSED INTO THE WELL. IF FOAMING OCCURS, HOSE DOWN THE FOAM AT THE MOUTH OF THE WELL. IF NECESSARY, AS A LAST RESORT TO STOP FOAMING AT THE MOUTH OF THE WELL, POUR SOME CALCIUM BICARBONATE DOWN THE WELL. THE NW-310 SHOULD OFFSET THE PROBABILITY OF CALCIUM CARBONATE PRECIPITATING IN THE WELL.

The drilling contractor will gravity feed the second Acid Treatment Solution Dose into the well following the same delivery strategy presented for the first dose, with the exception of IW-8. The small volume needed for IW-8 may be pumped into the well. Table 5 provides dispensing volumes.

If the top of the well screen is higher than the water level, then 25% of the acid treatment solution by volume should be placed into the well at the water table. Fifty-percent by volume should be placed into the well half way between the water table and base of the screen. Twenty-five percent by volume should be placed into the well at the base of the screen.

TABLE 5
DISPENSING VOLUMES FOR SECOND ACID TREATMENT SOLUTION DOSE

Well	25% just below the water table, (gallons)	50% at the top of the well screen, or half way between water table and base of screen (gallons	25% at the base of the Screen (gallons)	Total Volume dispensed (gallons)
IW-8	8	17	8	33
IW-9	21	43	21	85
IW-10	38	77	38	153
IW-11	54	107	53	214
IW-12	41	82	41	164

5.6 SURGING THE SECOND ACID TREATMENT SOLUTION DOSE IN THE WELL

The drilling contractor will quickly surge the second dose in the well to distribute the solution across the well screen (3 minutes at each 2.5-foot section). Water monitoring personnel will measure and record the pH of the well water using a pH strip. The well will then be allowed to sit overnight.

NOTES: In the past the stroke length of the rig used was 2.5 feet. If future rigs have a different stroke length, then a different surging schedule will need to be defined. A tight fitting surge block is defined as a dual swab surge block with a maximum of 1/2-inch clearance on all sides

The objective is to surge each 10-foot interval of the screen for 10 minutes.

5.7 SURGING JUST PRIOR TO PUMPING

The following day, Water Monitoring Personnel will bail a sample of water from the well and measure and record the pH using a pH strip.

The drilling contractor will surge the well again a minimum of 15 minutes at each 2.5-foot interval, beginning in the sump and progressing upwards.

NOTES: The objective is to surge each 10-foot interval of the screen for 60 minutes.

5.8 PUMPING THE SPENT ACID TREATMENT SOLUTION FROM THE WELL

Immediately following surging, Water Monitoring Personnel will measure and record the water level and pH (pH strip) in the well just prior to pumping. The pH measurement will be used to determine if neutralization of the purged groundwater will be necessary. If the pH is lower than 6, add sodium carbonate to raise the pH back into a neutral range. Sodium carbonate will be placed into the empty tanker, or a port in the discharge hose.

The drilling subcontractor will pull the surge block from the well, and install a water-pump capable of pumping 200 gpm.

The drilling subcontractor will provide an enclosed hookup from the well to a tanker truck. An enclosed hookup is one that is essentially isolated from the environment so as to minimize the probability of an accidental release. Chemicals may be added to the water pumped from the well for disposal purposes.

Pumping will begin as low in the well as possible given the pump being used and proceed until the water is clear. Then the pump will be moved up 10-feet in the well and pumping will continue until the water is once again clear. The pump will continue to be moved up the well in this manner until pumping is complete. If the top of the screen is reached before the required pump out volume, then lower the pump back down into he well as far as it will go and repeat the pumping process. A meter and totalizer will be used to measure and record the pumping rate and volume pumped. The pumping rate will be as high as the well will yield up to 200 gpm.

The water will be pumped into a tanker truck. The entire screen and sump will be pumped vigorously to remove as much debris and chemical mixture as possible. Volumes to be pumped at each re-injection well are provided in Table 6.

TABLE 6
VOLUMES TO BE PUMPED

Well	Volumes to be Pumped (gallons)
IW-8	3340
IW-9	8540
IW-10	15300
IW-11	21380
IW-12	16440

Note: Volumes to be pumped are equal to 20 times the total well volume.

Just prior to turning off the pump the water level will be recorded along with the pumping rate to calculate a specific capacity.

The well will be pumped until the pH of the well water returns to pH levels measured just prior to treatment. If the pH is not at pre-treatment levels, contact the ARWWP Engineer for instructions on how to proceed.

5.9 DETERMINING IF ACID TREATMENT WAS SUCCESSFUL

A successful acid treatment will be determined on a case by case basis. Criteria to be considered will include comparing specific capacities over time, past performance history of the well, the degree of residual plugging existing at the well, the expected life of the well, and the expected operational rate for the well. Additional acid treatments may be required prior to proceeding to the chlorination stage. ARWWP management will make this determination.

6.0 CHLORINATION

Prior to initiating the chlorination treatment, tanker trucks need to be committed to support pumping the spent chemicals from the well.

Following completion of a successful acid treatment, the following steps will be taken to administer a chlorination of the well.

CAUTION: THE pH OF THE WELL WATER MUST BE BETWEEN 6 pH UNITS AND 8 pH UNITS BEFORE BEGINNING THE CHLORINATION TREATMENT.

DANGER: SOLUTIONS OF SODIUM HYPOCHLORITE CAN GIVE OFF CHLORINE GAS!

6.1 MIXING THE CHLORINATION SOLUTION

The Site Drilling Contractor, under the direction of Fluor Personnel, will prepare a chlorination solution in holding tank(s) that consists of water, sodium hypochlorite and NW-310.

Mixing the chlorination solution will begin by adding a known volume of potable or treated water the tank. The starting volume of water for each re-injection well is listed in Column 2 of Table 7.

Add NW-310 to the starting volume of potable or treated water already in the tank. The volume of NW-310 to use for each re-injection well is listed in Column 3 of Table 7.

To the solution of potable water and NW-310, add the sodium hypochlorite. The amounts of NW-310 and sodium hypochlorite to use for each re-injection well are listed in Columns 3 and 4 of Table 7.

Blend the chlorination solution in the holding tank by re-circulating the mixture. A hose will lead from the base of the tank to the top, and a small pump will re-circulate the solution. Re-circulate the solution until approximately two volume turnovers have been achieved. Following blending, the pump use to blend the solution will be flushed with 5 gallons of water.

The total volume for each re-injection well is listed in Column 5 of Table 7.

TABLE 7
CHLORINATION SOLUTION VOLUMES

1	2	3	4	5
Well	Starting Volume of potable water (gallons)	Add gallons of NW-310	Add gallons of Sodium Hypochlorite	Total Treatment Volume (gallons)
IW-8	246	0.5	0.5	252
IW-9	632.5	1.0	1.5	640
IW-10	1138	1.0	2.0	1146
IW-11	1593	1.5	3.0	1602.5
IW-12	1225.5	1.0	2.5	1234

NOTES: Starting volumes shown in Table 7 are 5 gallons less than needed to arrive at the total volume shown in Column 5 of Table 7. Following blending of the chemicals, the operators will flush out the pump used to blend the chemicals in the tank with 5 gallons of water.

NW-310 is used to buffer the pH of the water before adding sodium hypochlorite.

Criteria for the volume of NW-310 used are one quart of NW-310 for, every 500 gallons of Total Treatment Volume), every 100 mg/L of alkalinity, and every 200 mg/L of chlorine used. The alkalinity of IW-8 and IW-12 is in the range of 200 mg/L. The alkalinity at the other re-injection wells will need to be measured prior to initiating a chlorination treatment. If the alkalinity is not close to 200 mg/L, the volume of sodium hypochlorite will need to be adjusted accordingly.

The objective is to have a chlorine concentration of 200 mg/L. The criterion for reaching this concentration is to use 1 gallon of sodium hypochlorite for every 500 gallons of the total volume).

The total treatment volume for each well is equal to the volume of water in the well, multiplied by 1.5, then multiplied again by 2.

6.2 GRAVITY FEED THE CHLORINATION SOLUTION INTO THE WELL

The Site Drilling Contractor will gravity feed the chlorination solution into the well just below the top of the water table.

6.3 SURGING THE CHLORINATION SOLUTION IN THE WELL

The Site Drilling Contractor will surge the chlorination solution in the well with a tight fitting surge block. Surge the well for 15 minutes at each 2.5-foot interval

The well will be allowed to sit overnight, or for a minimum of 6 hours if overnight is not possible. The chlorination solution should not be allowed to remain in the well for more than 24 hours.

NOTES: A tight fitting surge block is defined as a dual swab surge block with a maximum of ½-inch clearance on all sides. The sump will also be surged for at least 15 minutes.

The objective is to surge each 10-foot section of screen and sump for 60 minutes.

6.4 PUMPING THE SPENT CHLORINATION SOLUTION FROM THE WELL

DANGER: SODIUM THIOSULFATE SHOULD NEVER BE MIXED DIRECTLY WITH ANY OTHER PURE CHEMICAL

The following day, the Site Drilling contractor will surge the well again briefly (5 minutes at each 2.5-foot interval of screen and sump).

The Site Drilling Contractor will then pull the surge block from the well and install a pump capable of pumping 200 gpm or more.

An enclosed hookup from the well to the tank will be provided. An enclosed hook up is one that is isolated from the environment so that the probability of an accidental release is reduced.

The well will be pumped vigorously to remove as much spent chlorine and dead bacteria as possible. A meter will be used to measure and track the pumping rate.

Start pumping as low in the well as possible given the pump being used and continue until the pumped water is clear. Then the pump will be moved up 10 feet in the well and pumping will continue. A meter and totalizer will be used to measure and record the pumping rate and volume.

The water will be pumped to a tanker truck. Volumes of water to be pumped from the well are provided in Table 10. Water Monitoring Personnel will measure the chlorine level of the water in the tanker for disposal purposes. AWWT personnel will conduct the chlorine measurement using a colorimeter.

Chemicals may be added to the treated groundwater for disposal purposes. Sodium thiosulfate shall be used to de-chlorinate groundwater treated with sodium hypochlorite. The sodium thiosulfate shall be placed in the empty tanker or added to an empty discharge hose, via a chemical port, to contact treated ground water.

TABLE 10
PUMPING VOLUMES

Well	Pumping Volumes (gallons)
IW-8	1260
IW-9	3200
IW-10	5730
IW-11	8010
IW-12	6170

7.0 POST TREATMENT ACTIVITIES

After completion of the redevelopment process, Water Monitoring Personnel shall measure the water level and total depth of the well using EM Procedure SMPL-05, *Groundwater Level/Total Depth Measurements*.

A sample of groundwater shall be bailed from the well. Field water quality parameters (pH) of the sample shall be measured per EM Procedure EQT-02, *Horiba Water Quality Meter*. Samples will also be collected for analysis of chlorides and ortho-phosphates. Sample container types and preservatives are tabulated below.

POST-TREATMENT SAMPLE

Number of Samples	Sample Matrix	Analyte List	Method of Analysis	Preservative	Sample Volume	Container Type	Laboratory	Sample Turn Around Time
1	Water	Chloride Ortho-phosphate	2504 2516	Cool to 4° C	500 ml	Plastic	AWWT	7 days

A brief performance test will be conducted to determine whether or not the well should be put back into service. Treated water from the AWWT will be injected into the well at a rate of approximately 200 gpm (or other rate designated by the Engineer), for approximately 1-hour or until water levels have appeared to stabilize. The rate of water level rise in the well will be measured periodically. If the water level rises completely up to the designated action level for the well, the treatment will be considered unsuccessful. Initial success will be achieved if the water level does not rise up to the designated action level during the performance test. The degree of initial success will be initially determined subjectively by considering the following criteria:

- Age of the well,
- Operational history of the well,
- Degree of residual plugging, and
- Anticipated future life of the well.

Ultimate success of the treatment will be judged through the actual operation of the well. If the operational life of the well is equal to, or only slightly less than what it was before the treatment then the treatment will be considered a success.

Water Monitoring Personnel shall complete a downhole camera survey of the well per EM Department Procedure EQT-08 *Down-hole Camera*. The objective of the camera survey is to document the condition of the screen following the treatment. Time will be provided for the turbidity in the well water to settle out prior to conducting the survey. Results of the video shall be reported to the ARWWP Engineer. The videotape of the camera survey shall be archived in Water Monitoring project files for future reference or review.

The drill rig shall be demobilized and well equipment reinstalled by ARWWP Operations personnel. The water collection tanker trucks will be cleaned following completion of rehabilitation activities as directed by radiological technicians. The radiological technicians shall survey the tanker trucks prior to being removed from the Fernald Environmental Management Project (FEMP).

8.0 WASTEWATER DISCHARGE AND CHEMICAL DISPOSAL

Disposal and handling of collected wastewater from the well shall be coordinated with ARWWP Environmental Compliance. A *Wastewater Discharge Approval Request* (Form FS-F-4045) for each tank collected must be approved by an Environmental Compliance Engineer. Historically the purged water has been discharged to the storm water retention basin; however, the Environmental Compliance Engineer may direct alternate locations as documented in the approved *Wastewater Discharge Approval Request*. Any acidified wastewater must be accompanied by pH information. Any chlorinated wastewater must be accompanied by a measurement of residual chlorine. Residual chlorine should be no larger than 0.1 mg/L. Empty chemical containers and any excess chemicals shall be removed from the FEMP by Moody's immediately following completion of well rehabilitation. Used pads and wipes shall be disposed of in closed plastic bags to a site Dumpster.